NEDA – status, perspectives for installation in Poland and possible physics case

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NEDA (NEutron Detector Array) is the next generation neutron detection system designed to be a versatile device, with high-detection efficiency, excellent neutron-gamma discrimination and high rate capabilities. The primary application of NEDA is to serve as a fast neutron multiplicity filter, operating in conjunction with state-of-the-art gamma-ray spectrometers. Such a complex detecion system provides optimal conditions to perform studies in regions far from the valley of beta stability. Experimentally those regions are accessible via, inter alia, fusion-evaporation reactions in which the nuclei of interest are produced by the emission of a few particles from the compound nucleus. The arrays of HPGe detectors, used for these studies, have to be complemented with ancillary devices, which make possible accurate identification of the reaction products, and thus of the reaction channel. In particular, when approaching very neutron-deficient nuclei the channels with neutron emission lead to the most exotic nuclear structures, which are produced with very small cross sections. With the purpose of identifying neutron-evaporating reaction channels, large arrays of liquid scintillator detectors like the Neutron Wall and the Neutron Shell were constructed in the past and successfully used in many experiments, aiming at the study of more and more neutron deficient nuclei, especially along and close to the N = Z line, up to the region of the doubly magic ^{100}Sn. The existing devices are rather well suited for the detection of single or maximum two neutrons, achieving efficiencies of ~20% and ~2% in symmetric fusion-evaporation reactions for clean detection of one and two neutrons, respectively. The efficient identification of events with neutron multiplicity two and larger is difficult, since it requires both large granularity of the array and excellent neutron-γ discrimination (NGD) capabilities.

The NEutron Detector Array was currently built in its first implementation to address the above-described demand and make possible the nuclear structure investigations of not-achievable so far exotic neutron-deficient nuclei. The first implementation of NEDA already over-performs the predecessors, reaching 30% and 4.5% for clean identification of one and two neutrons emission, respectively.

From the very beginning Poland contributes in the development of the NEDA project. We had the major impact on the choice of design of single cell, array and the type of the scintillator. The self-production of the detectors was handled by the Polish manpower. We have proposed the experiments in the first NEDA host laboratory and contributed to the installation and operation of the first physics campaign of NEDA in GANIL in 2018.

Installation of the NEDA array, as the ancillary device for a powerful gamma spectrometer, as AGATA, operating with the high current heavy-ion cyclotron in Warsaw would make HIL a dream place for performing studies of exotic neutron-deficient nuclei at and beyond the limits of what is currently achievable in terms of cross-sections.

Besides serving as a neutron multiplicity filter, depending on the physics case, NEDA can also be used as a fast neutron spectrometer or to tag neutrons e.g. in transfer reactions, further enriching the instrumentation possibilities of HIL.

In the talk I will summarize a decade of research and development phase of NEDA and describe its current status and features. I will present possible physics cases in HIL, especially along N=Z line close to the doubly magic nuclei.